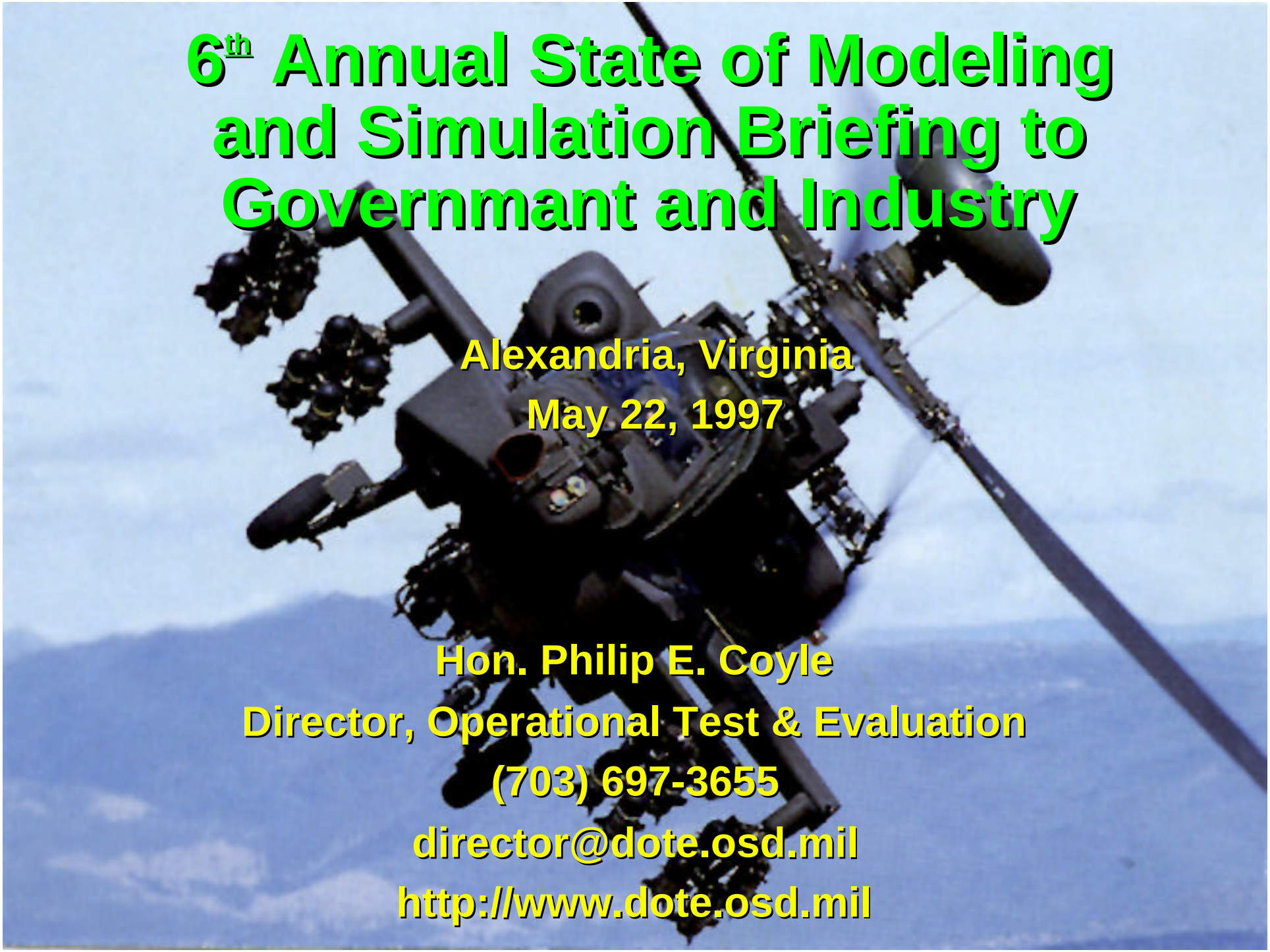


6th Annual State of Modeling and Simulation Briefing to Governmant and Industry

Alexandria, Virginia

May 22, 1997

Hon. Philip E. Coyle

Director, Operational Test & Evaluation

(703) 697-3655

director@dote.osd.mil

http://www.dote.osd.mil

CONFERENCE OBJECTIVES

- Common perspectives
- Exploit M&S potential
- Discuss applicability--two-way dialog
- Review supporting capabilities
- Gain insights to effective M&S
- Emphasize your role

WHY M&S?

- Gain understanding
- Learn early; significance of what is found in contractor testing
- Smooth transition between phases
- Achieve long-term savings
- Reduce cycle time
- Cost/performance analysis

WHY THE CONCERN?

- We don’t use M&S as well as we could
- Cannot afford to build many different single-use models
- Great potential for applicability from design and manufacturing to test and evaluation
- Need greater understanding

CRADLE TO GRAVE APPLICATION

- Combat development
- Engineering and manufacturing development
- Test and evaluation
- Training
- Sustainment

Modeling & Simulation

STRONG DOT&E SUPPORT FOR M&S

- My own experience
- Cuts across doctrine, training, leadership, organizations, material
- Critical to future success

M&S CONTRIBUTIONS

- Design
- Manufacture
- Subcomponent Testing
- AOA
- Development
- Operational Evaluation
- Test Planning
- Training
- Logistic Support
- JWCA

MOD/SIM CHARACTERISTICS

- Realistic
- “Physics” based
- Highly predictive

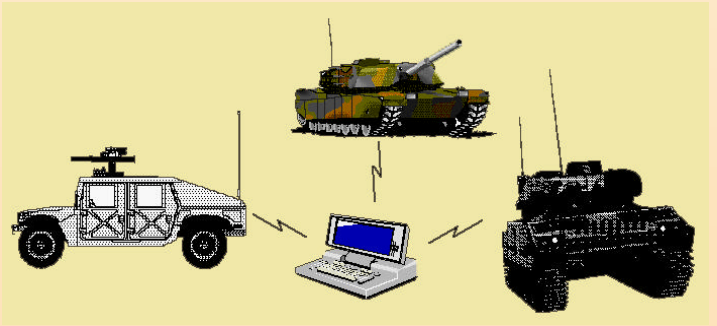
MYTHS

- Operational testers won't use M&S
- M&S is cheap
- Testing and M&S are opposite ends of a balance scale

TRUTH IS: M&S and testing are intertwined; when they are not, neither is effective

EXAMPLES

- **Predator (requirements refinement)**
- **Sealift (design)**
- **C-17 (design, TTPs)**
- **Janus (test planning)**



PREDATOR
(REQUIREMENTS REFINEMENT)

Background and Motivation

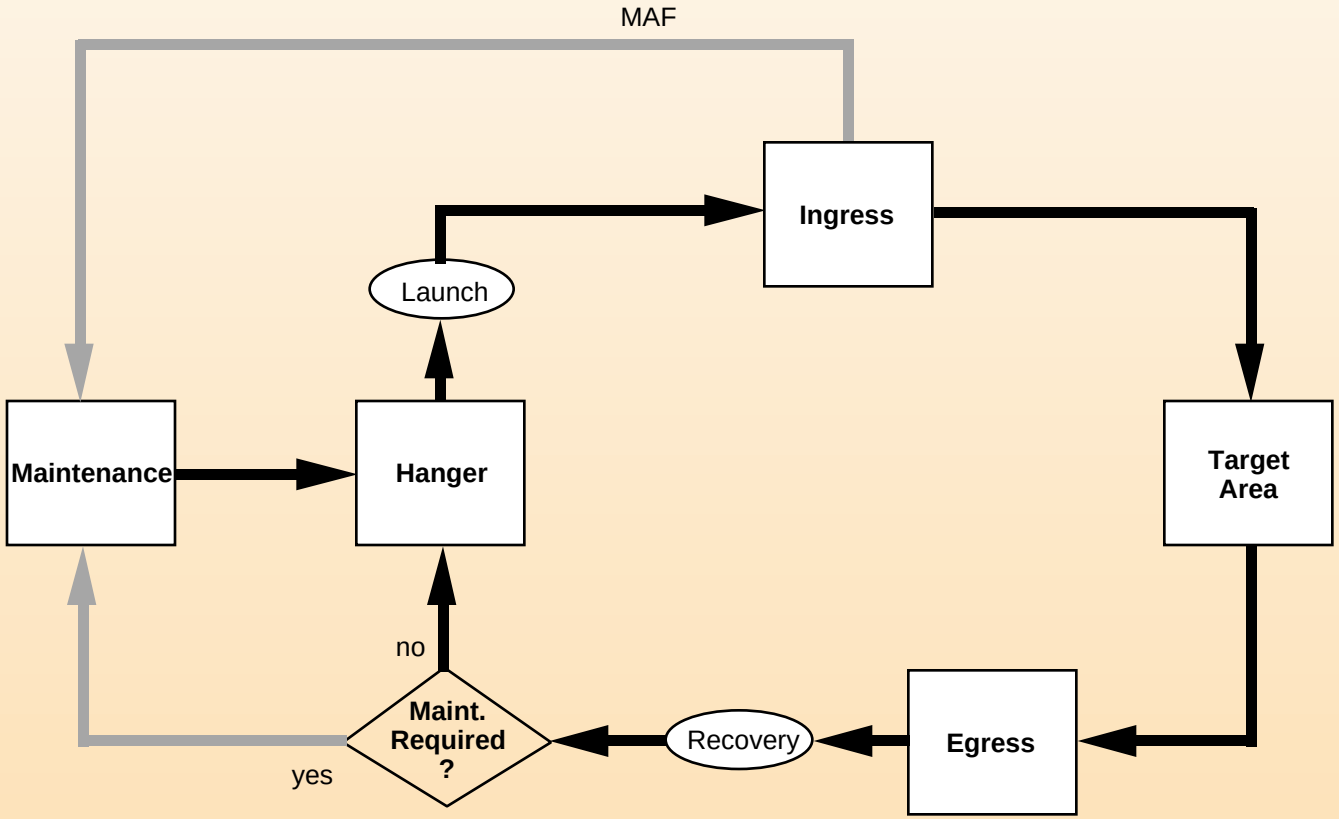
“Presence” Key Performance Parameter (KPP)

“The baseline MAE UAV system must be capable of continuous (with on-station relief) 24 hour intelligence coverage of any target in the operating area.”

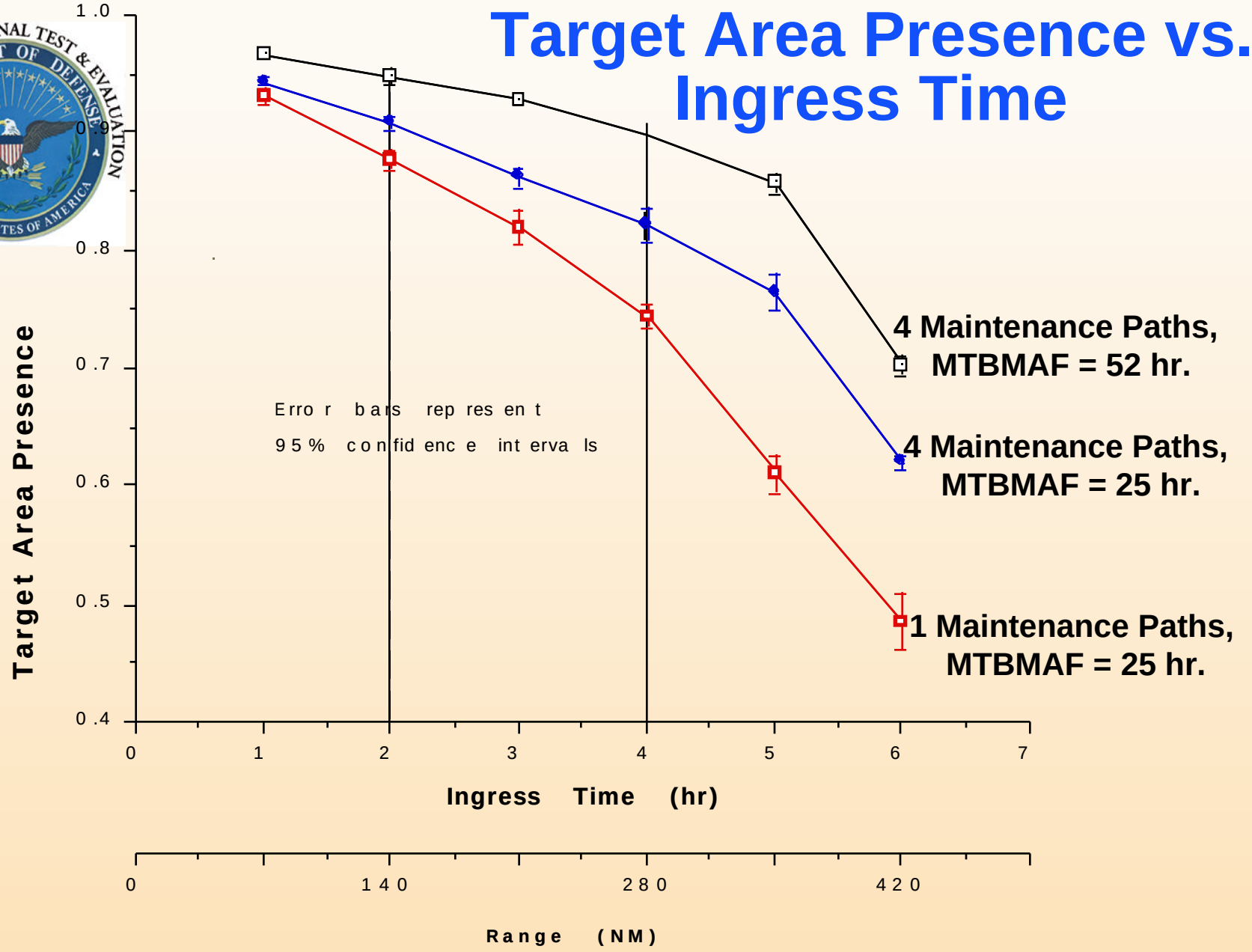
- **Continuous target area coverage never before attempted with Predator**
  - **have not demonstrated simultaneous control of multiple air vehicles**
  - **no typical operating range has been defined (CONOPS)**

Methodology

- **Discrete-event simulation developed to predict target area presence**
  - **Extend™ simulation environment on Macintosh host**

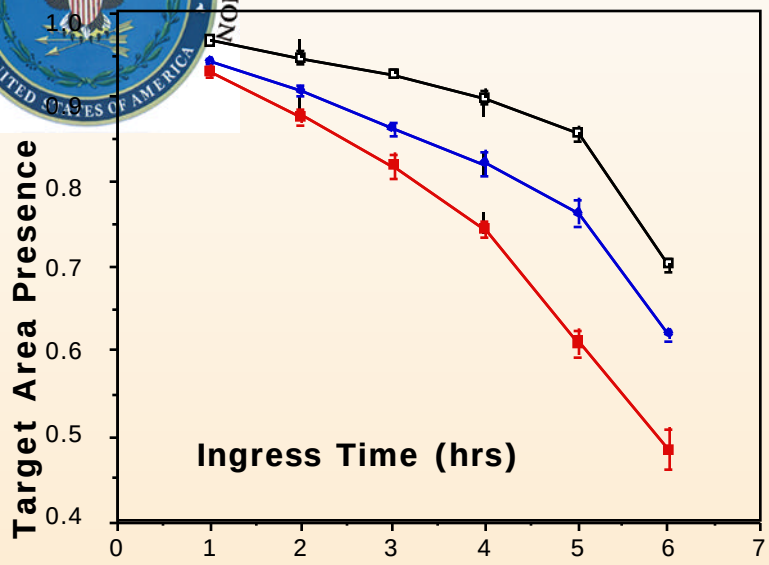


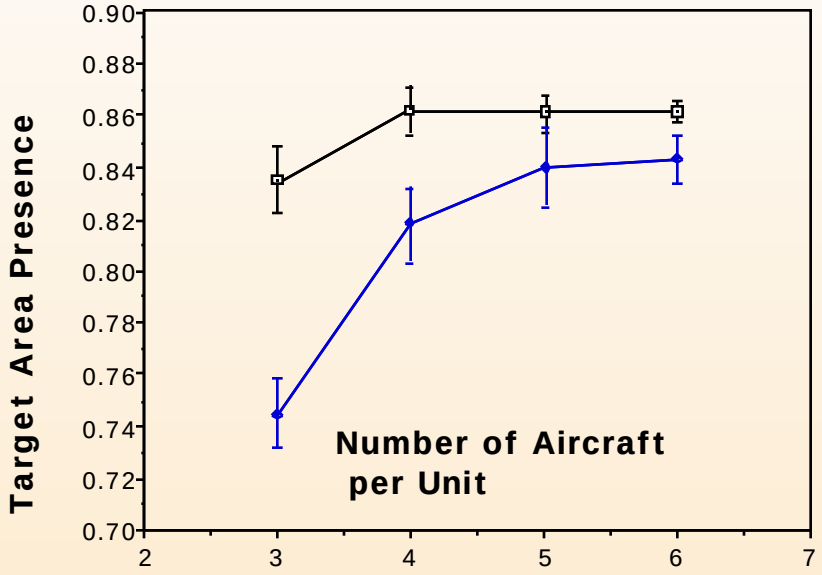
Target Area Presence vs. Ingress Time

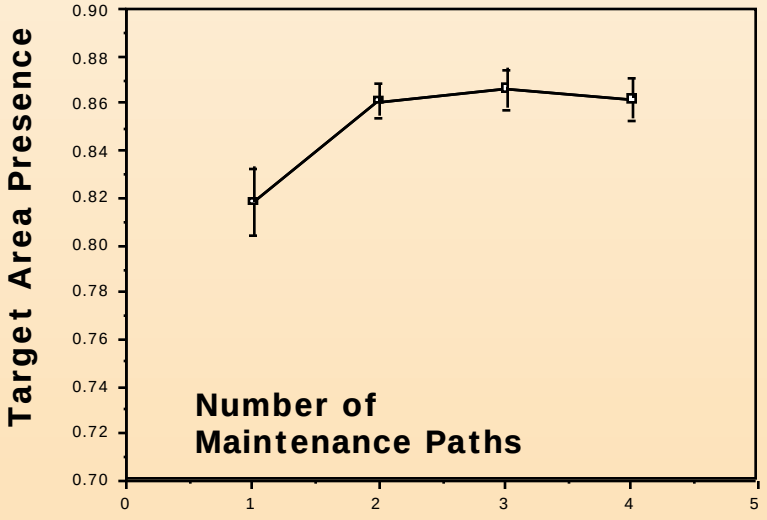


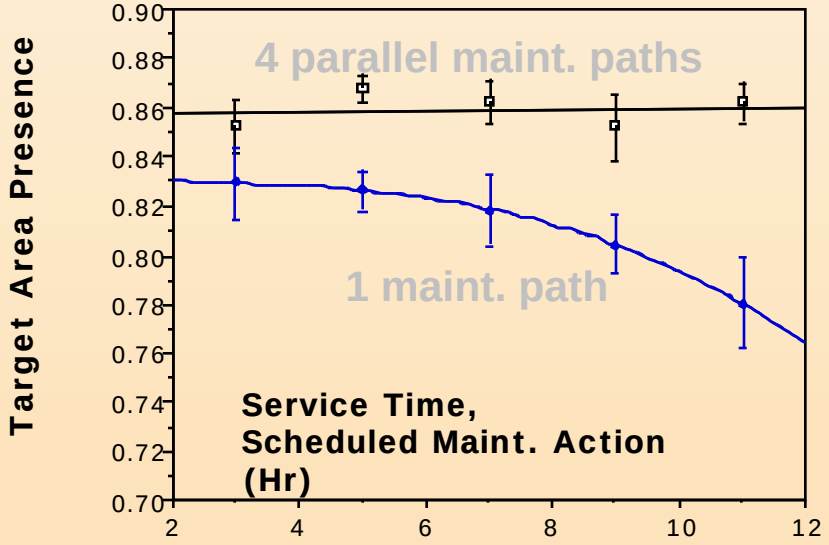
Range scale assumes 70 knot ground speed

Target Area Presence vs.









Conclusions/Recommendations

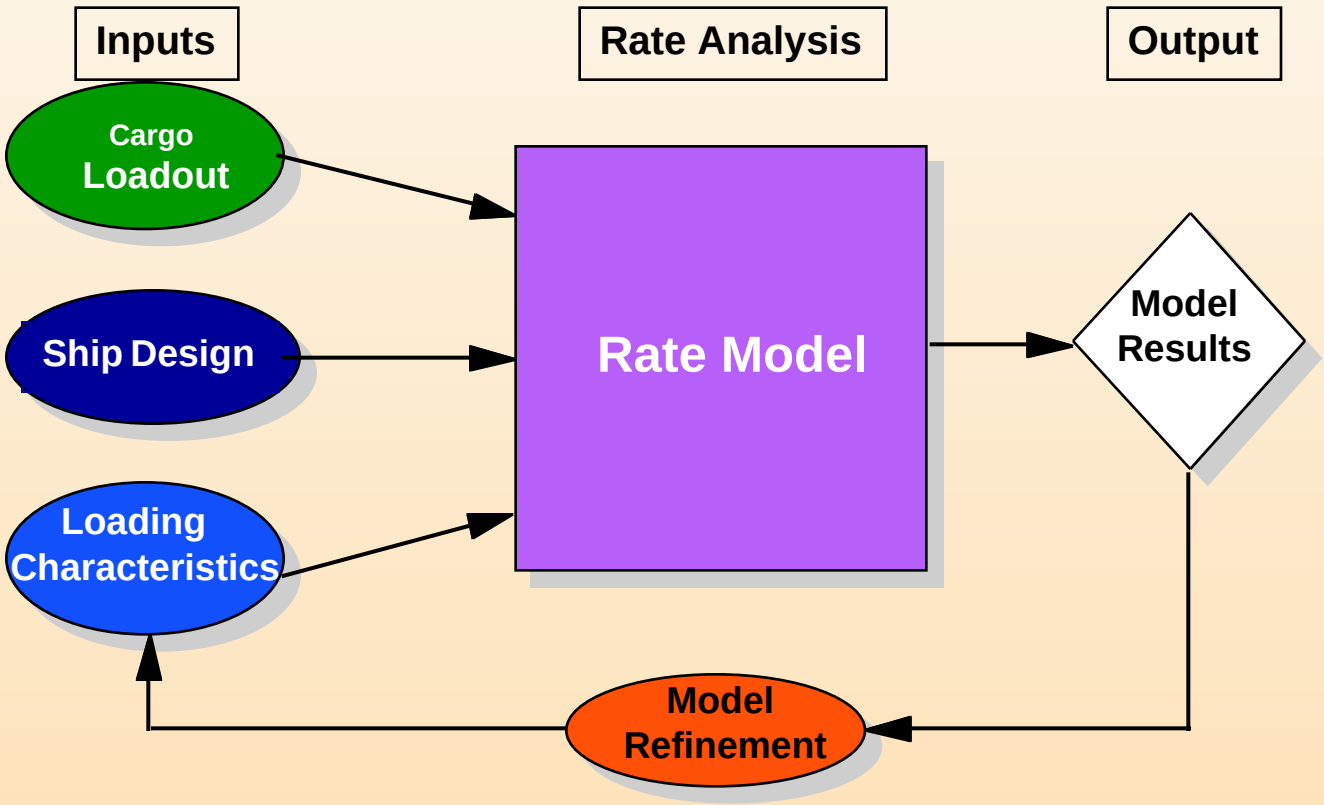
- **Optimum target area presence is a function of many variables**
  - **4 air vehicles per system**
  - **dual air vehicle control**
  - **no weather**
  - **short transit times**
  - **optimistic maintenance assumptions**
  - **highly sensitive to transit time (6 hr ingress time reduces best case presence to < 70 %)**
  - **maintenance assumptions (changing to serial maintenance reduced target coverage by 1-13%)**
  - **available air vehicles (from 4 to 3 will reduce target coverage by 3 to 8 %)**
- **Predator IOT&E Test Plan should include realistic threshold for target area presence**
- **Threshold should be associated with a specific range to target area**
- **Maintenance concept should be defined**
- **Manner in which weather-affected missions are to be scored should be explicitly stated**

STRATEGIC SEALIFT
(M&S IN DESIGN)

STRATEGIC SEALIFT RATE MODEL REQUIREMENT

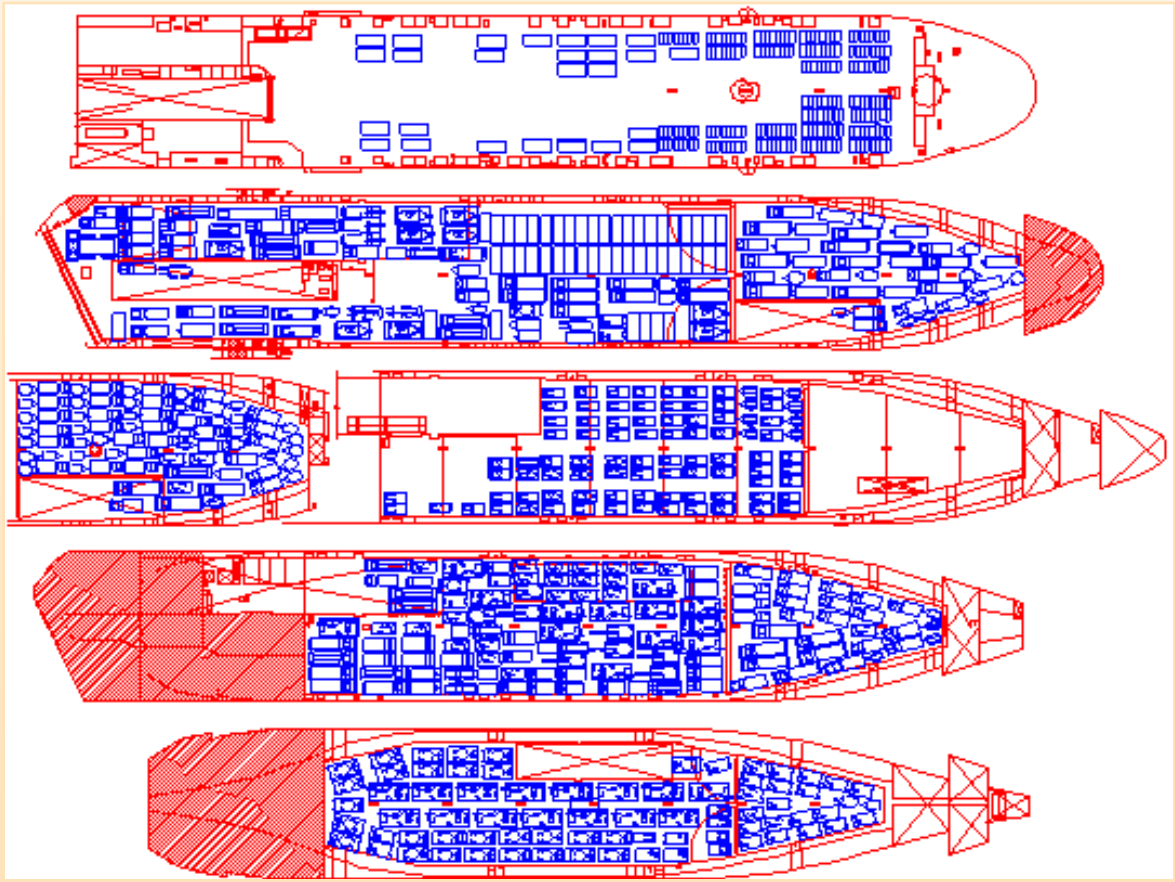
- **THE MATERIAL DEVELOPER NEEDED TO ACCOMPLISH THE FOLLOWING TASKS IN SUPPORT OF THE STRATEGIC SEALIFT ACQUISITION PROGRAM:**
  - **EVALUATE THE CARGO LOADING CAPABILITY OF PROPOSED RO/RO SHIP DESIGNS FOR NEW CONSTRUCTION AND THE CONVERSION OF EXISTING SHIPS;**
  - **ESTIMATE THE LOAD PERFORMANCE (LOADING RATE IN PIECES AND SQUARE FEET PER HOUR) OF THE STRATEGIC SEALIFT SHIPS USING OPERATIONAL LOADING CRITERIA; AND**
  - **EVALUATE THE ABILITY OF THE DESIGNS TO MEET THE 96 HOUR ON-LOAD/OFF-LOAD REQUIREMENT ESTABLISHED BY THE STRATEGIC SEALIFT OPERATIONAL REQUIREMENTS DOCUMENT (ORD).**

STRATEGIC SEALIFT RATE MODEL



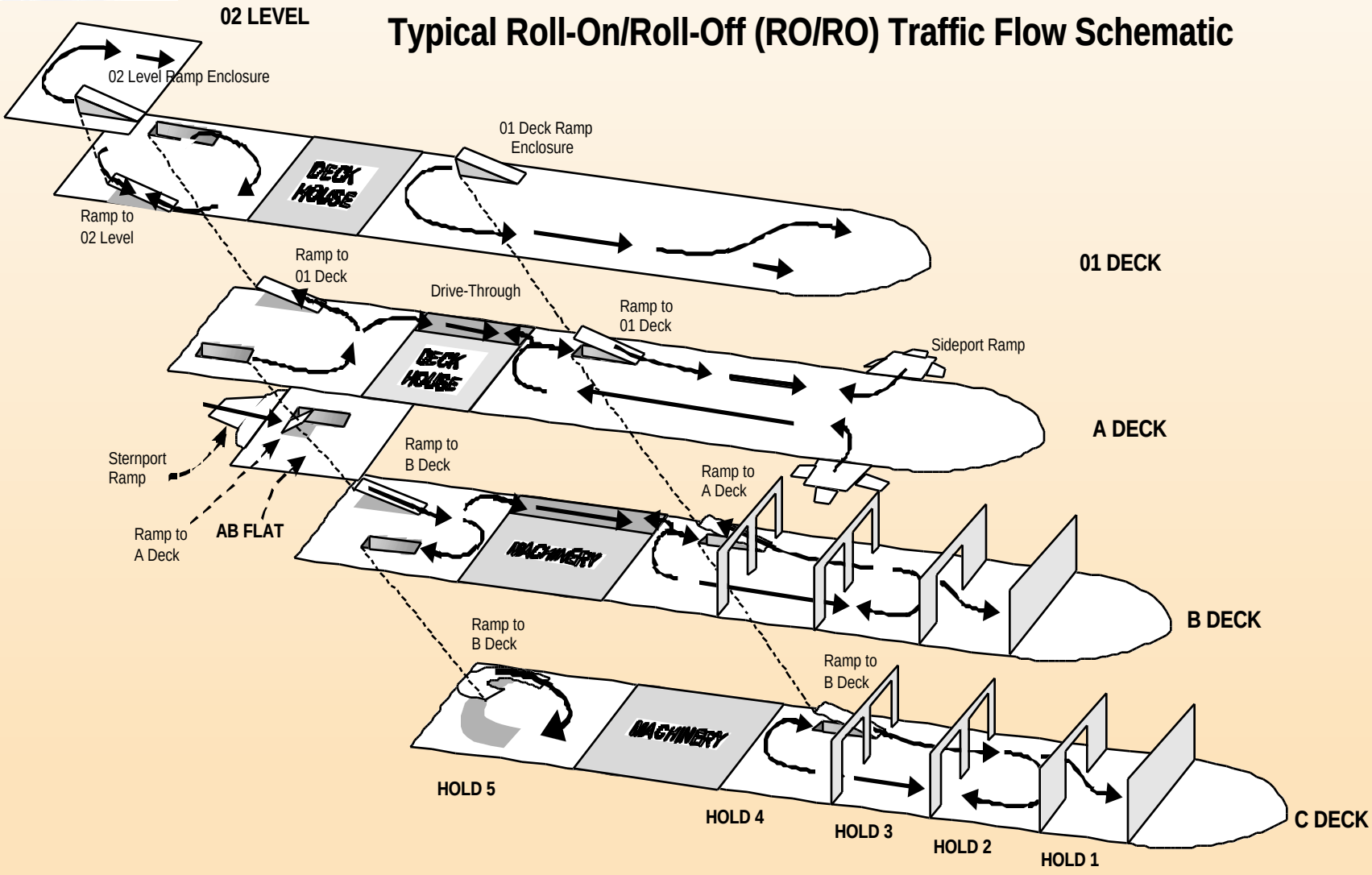
STRATEGIC SEALIFT CARGO LOADOUT

Typical Roll-On/Roll-Off (RO/RO) Stowage Schematic



STRATEGIC SEALIFT SHIP DESIGN AND LOADING CHARACTERISTICS

Typical Roll-On/Roll-Off (RO/RO) Traffic Flow Schematic




SSRM
VISUALIZATION

STRATEGIC SEALIFT RATE MODEL

- **THE RATE MODEL HAS BEEN USED AS:**
  - **A TOOL FOR THE SHIP DESIGNERS**
  - **AN AID FOR DEVELOPMENTAL TESTERS**
- **VV&A UNDERWAY AT NAVY OTA:**
  - **POSSIBLE OT ASSESMENT/EVALUATION TOOL**
- **IF VV&A SUCESSFUL, PLANNING TOOL FOR CINCs:**
  - **STOW PLANNING**
  - **REQUIRED LOADING RESOURCES IN THEATER**
  - **OFFLOAD TIME IN THEATER**

C-17 AIRLIFT AIRCRAFT

Modeling in Design and Development of Tactics, Techniques and Procedures

Background & Motivation

- **USA Strategic Brigade Airdrop Mission**
  - **Rapid delivery of paratroops and heavy equipment to a distant conflict**
  - **Mission now performed by aging C-141**
  - **C-17 designed to replace C-141**
- **Deficiencies discovered in C-17 IOT&E**
  - **Paratrooper entanglement/interference**
  - **Paratrooper interactions with wake vortex**

ADM: #1 Priority in FOT&E

- **Flowfield turbulence and convergence behind C-17 increase entanglement risk**
  - **Limit airdrop options and configurations**
  - **Not identified in wind tunnel**
- **Wake vortices upset/collapse parachute**
  - **Vortices dictate new airdrop formations**
  - **Within- and between-element spacings**
  - **Initially inadequate data and models**

Turbulent & Convergent Air

- **Turbulent air under C-17 T-tail**
  - **Precluded static line drops from ramp**
  - **Caused D-bags to hit some jumpers**
  - **Static lines lengthened from 15 to 20 feet**
- **Convergent airflow behind C-17**
  - **Wide body displaces more air than C-141**
  - **Airspeed reduced, flap setting changed, deck angle increased: fewer entanglements**

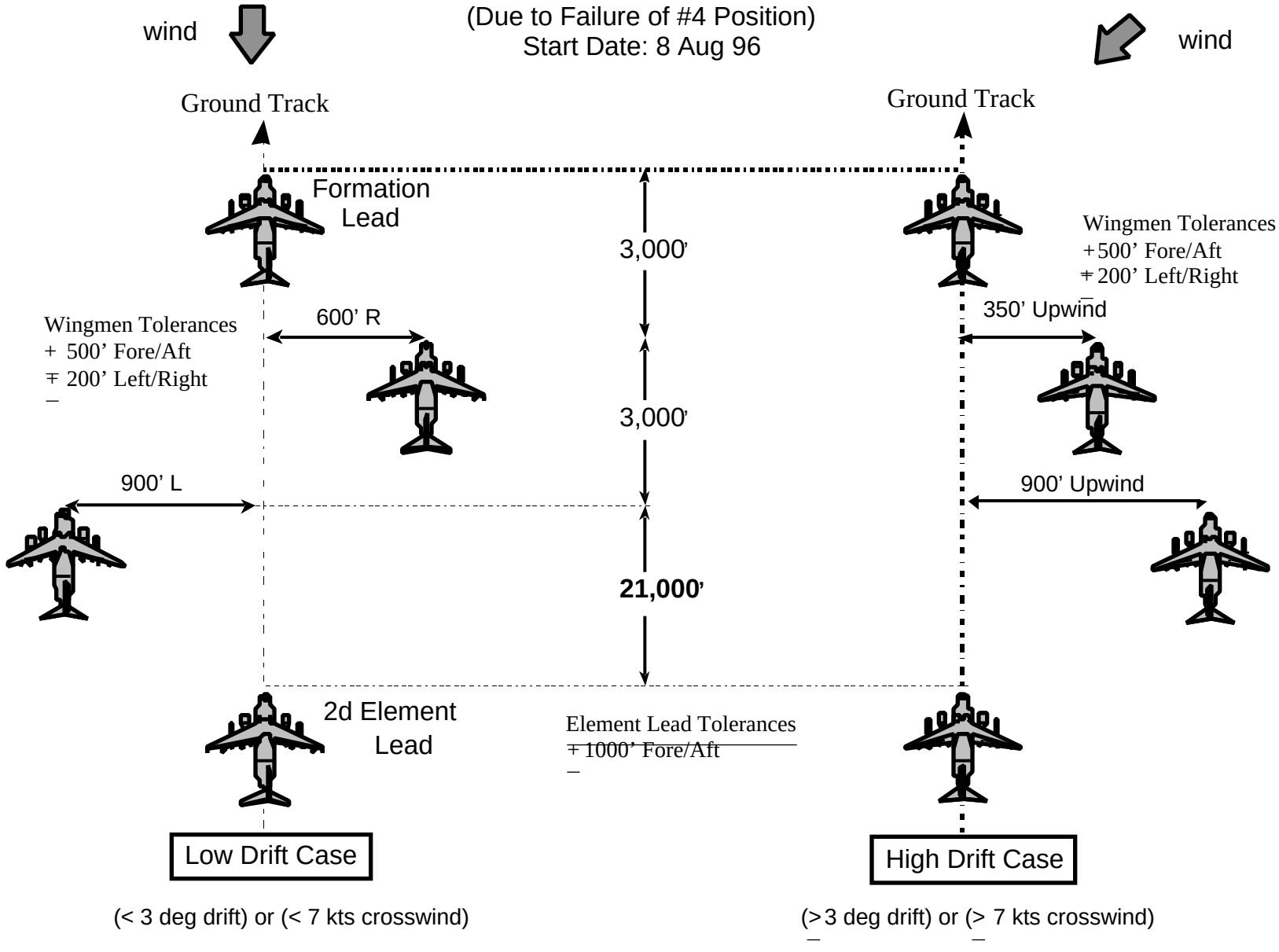
Wake Vortices

- C-17 paratroopers at risk with standard formation spacing (a la C-141)
- Strength & persistence of C-17 vortices not considered in IOT&E
- No vortex measurements during IOT&E
- LIDAR data collected between end of IOT&E and start of FOT&E
- Wright Labs had “only model in town”

Formation Airdrop Evolved

- AMC standard rejected in IOT&E
- 3 distinct within-element and 3 distinct between-element spacings in FOT&E
- Iterative comparison of Wright Labs simulation output with actual airdrops
  - Mannequins first, then live paratroopers
  - Built from single C-17 to 6-ship airdrop

Rev #3. C-17 Formation Geometry



Note: Changed Values Bold

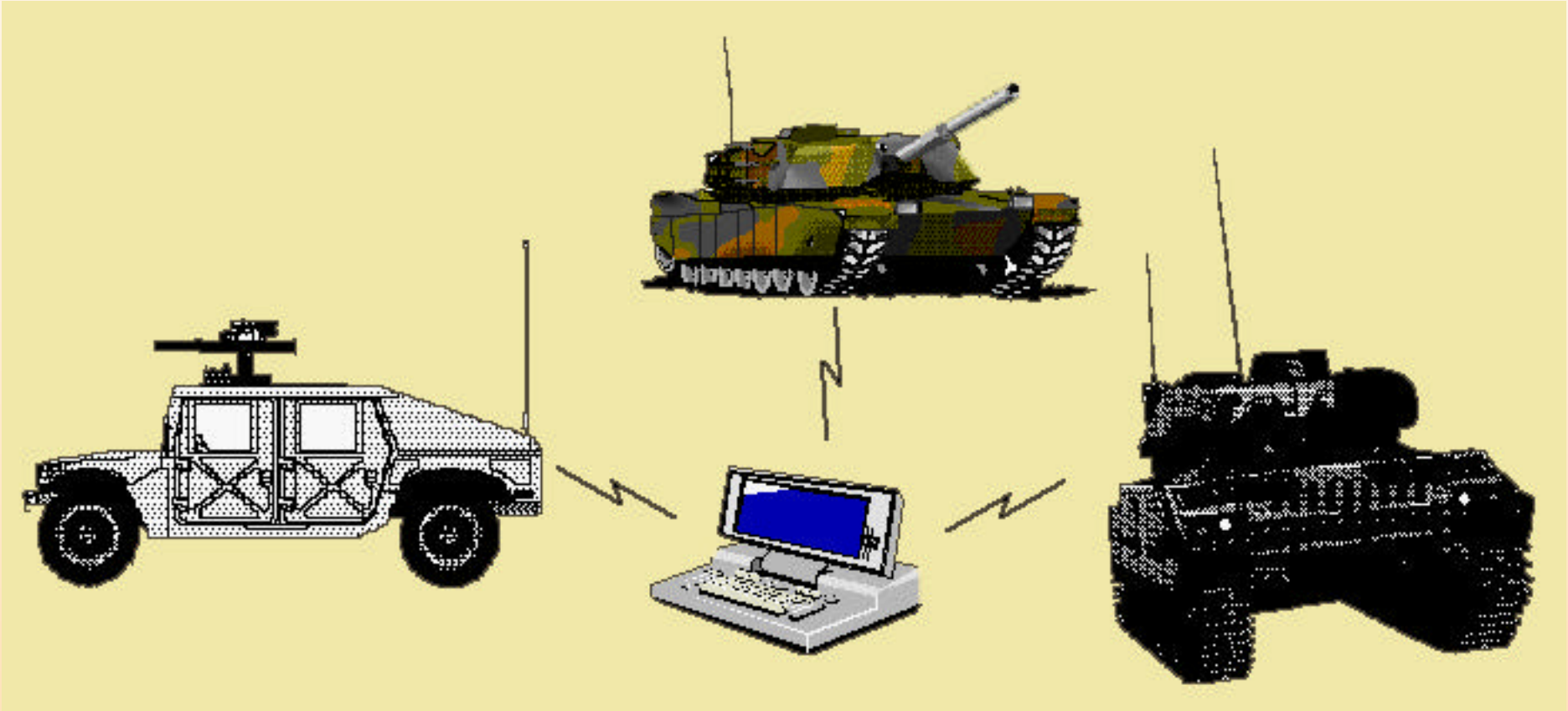
Simulations Still Evolving

- Theory without data at the outset
- Computer simulation at Wright Labs
  - Strength and persistence “guesstimates”
  - Parachute trajectories not realistic
- LIDAR measurements yield some data
- Enhanced simulation started at AFIT
  - “Slices” of the vortex tubes modeled
  - USA help with parachute trajectories

Current Status

- **Interim intra-element and inter-element airdrop formation and flight parameters**
  - **Brigade airdrop timing issue unresolved**
  - **Station Keeping Equipment needs upgrade**
- **Work on AFIT simulation continues**
  - **Visualization being added**
  - **Risk analyses of alternatives possible**

JANUS:
USING A MODEL THAT EXISTS TO Analyze OT&E



Anticipated ITAS Benefits

- **Improvements over existing TOW 2**
  - **Target detection and recognition at longer ranges**
  - **Reduced target acquisition time**
  - **Greater Probability of Hit**
  - **Improved Reliability, Availability and Maintainability**
  - **Laser Range Finder**
- **Bottom Line**
  - **Improved force effectiveness with units equipped with ITAS.**

Use of Janus to Extend Operational Test Results

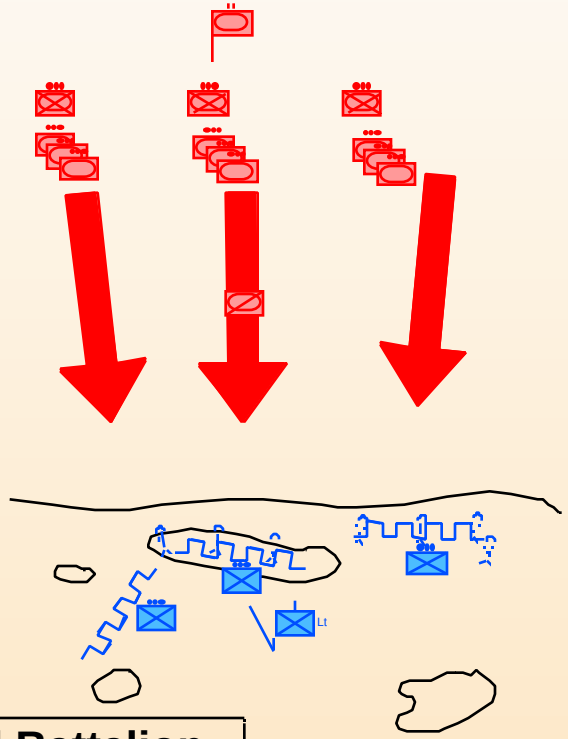
- **Objective**
  - Determine the feasibility of using available simulations in conjunction with OT data to investigate operational effectiveness in a force-on-force scenario
- **Improved Target Acquisition System (ITAS) selected for pilot study**
  - OT data (LUT) was available
    - » Detection trials only
    - » No force-on-force phase
  - Potential applicability of results to other programs that utilize second generation thermal viewers
- **ITAS provides improved target detection and recognition at longer ranges over existing TOW 2**

Methodology

- **Janus simulations**
  - Developed scenarios (mission, terrain, forces)
  - Modified Janus detection algorithm to reflect ITAS LUT data
  - Replicated battles, collected and analyzed data
- **Analysis Plan**
  - Side-by-side comparison
    - » Baseline: TOW Janus Standard Detection Model
    - » Case 1: TOW LUT Detection Model
    - » Case 2: ITAS LUT Detection Model
  - Issue: Is the force effectiveness of an ITAS-equipped force improved over a TOW-equipped force?
  - Scenario designed to allow ITAS to demonstrate advantages
    - » Night
    - » Long range field of fire

The Scenario

- **Modified US Army High Resolution Scenario 29.**
- **Designed to allow ITAS to demonstrate advantages**
  - **Night**
  - **Long range field of fire**
- **Other Scenario Features**
  - **No Smoke**
  - **No Blue Armor, Helicopters or Artillery Support**

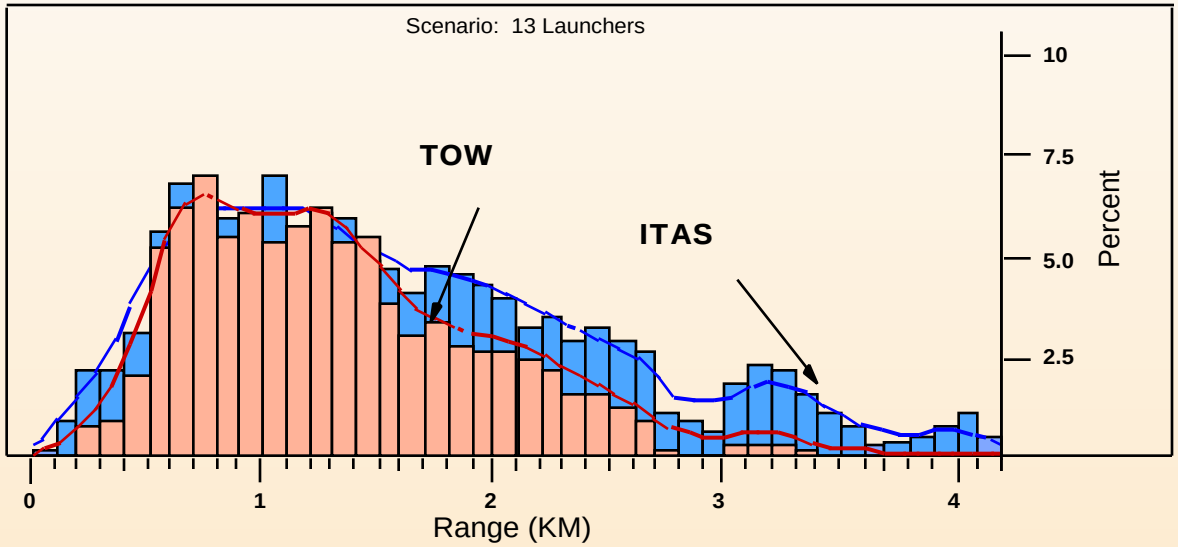


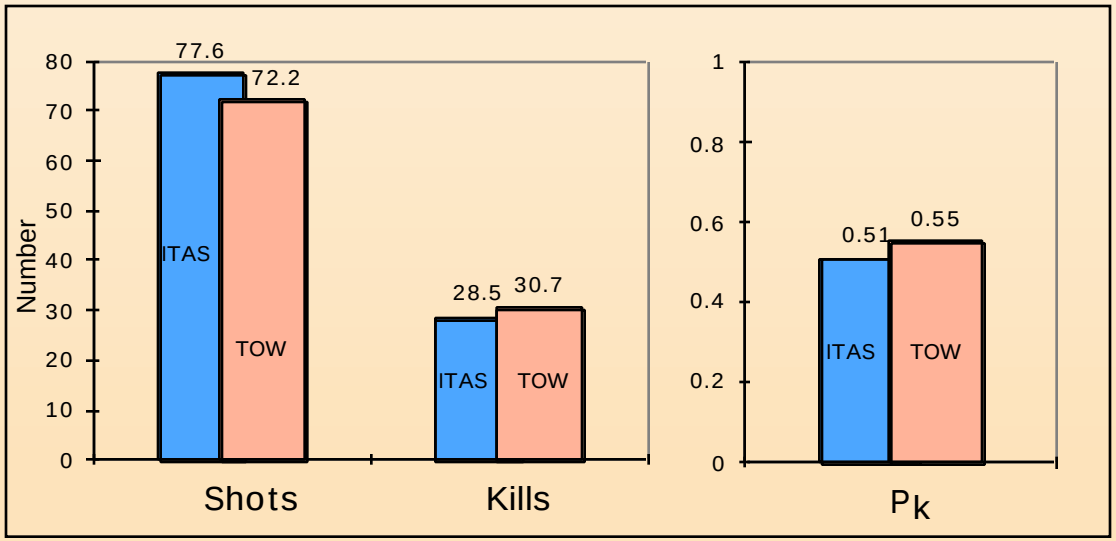
Order of Battle for Pilot Study Scenario

U.S. Light Infantry Company		OPFOR Armored Battalion	
No.	**System**	**No.**	**System**
6	M-60 Machine Gun	31	T72
18	SAW	11	BMP-2
6	Dragon	5	BTR-60
2	60mm Mortar	–	–
105	Rifleman	–	–

Model Results

Relative Distribution of Identifications by Range



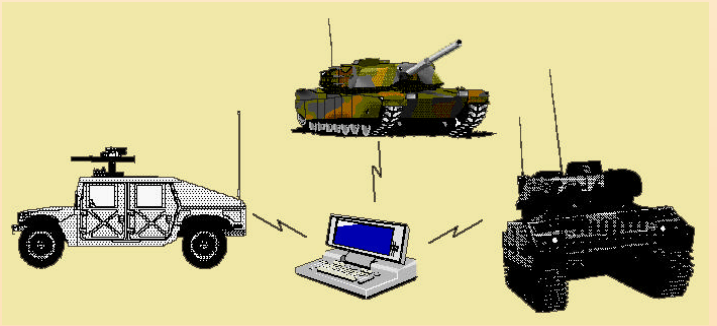


Janus Results for ITAS

- It was feasibile to use computer simulations to extend test results to make limited conclusions about force effectiveness
  - ITAS better able to detect targets at long range, but not able to convert detections into kills
  - Higher probability of hit at longer range can help ITAS take advantage of improved detection capability
- Feasibility of using Janus to extend test results demonstrated
  - Relatively easy to use
  - But, must pre-plan to meet typical timeline to support test approval or B-LRIP decisions
- Future Plans
  - Bradley IOT&E
  - FOTT

EXAMPLES

- **Predator (requirements refinement)**
- **Sealift (design)**
- **C-17 (design, TTPs)**
- **Janus (test planning)**



DEVELOPING A SIMULATION STRATEGY

- Establish evaluation strategy early enough to refine requirements; contractors have a right to know how the system will be evaluated
- Use backwards planning from the IOTE
- Determine M&S deliverables; RFP requirements
- Complementary models, simulations, tests
- Early applications
- Expanding the envelope
- Long-term perspective, not just the next milestone
- Develop for reuse and multiple use
- Constantly improve models

STRATEGY DEVELOPMENT (con't)

- Program funds
- Refine mod/sim/test rationale
- Demonstrate success in early phases
- Ensure continual feedback
- Articulate insights
- Involve trainers
- Sustainment, integration considerations

EXPECTATIONS

- Earlier involvement
- IPTs
- TEMPS that pay close attention to M&S, especially highly predictive ones
- CAD/CAM to vulnerability model links
- OT&E events planned with model runs
- Predict OT&E results via M&S
- Continuously improve models with test results
- Understanding: Insight not Oversight
- Budgets for M&S

THE FIRST STEPS

- Develop an M&S master plan
- Decide what you'll try to model and simulate
- Talk to the T&E folks while you do it
- Budget for it

CONCLUSIONS

- We have great support
- Expectations have never been higher
- Success requires new investment in M&S
- M&S and testing are mutually supportive
- M&S and testing are intertwined